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Experimental Results on the Preservation of Fruits and Vegetables by Freezing

A PROGRESS REPORT

By

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THIS progress report has been issued in response to increasing demands for information on the preservation of fruits and vegetables by freezing. Locker storage, and even new commercial developments, have indicated a need for more detailed information on the work thus far developed. Locker storages are increasing by the thousands annually, and this fact has brought about a need for information for housewives who are eager to utilize such storage facilities in preserving food stuffs by this comparatively new method.

Freezing affords one of the simplest methods of preserving foods. With the rapid rise in the use of frozen fruits and vegetables, there has developed a demand for more information on packing, freezing, and storage of these products. Although the steps involved in freezing are simple, there are a few fundamental rules that should be followed if the results are to be successful.

Too much emphasis cannot be given the fact that fresh fruit or vegetables used for freezing should be of the highest quality; and as maturity affects the flavor, the stage of maturity should be watched. Green or overripe fruit should not be used because the products will be flavorless when "defrosted." Over-maturity in vegetables will mean a very tough and stringy product, the flavor and appearance also changing with age. The best stage of maturity for eating or other use in the fresh stage is also the best condition for freezing.

TEMPERATURE FACTORS

Freezing temperatures for fruits and vegetables. The results from research at this Station (1) indicate that temperatures ranging from 5° below zero to 5° above zero Fahrenheit are satisfactory for freezing either small or large containers of fruits and vegetables. If locker storages and freezing rooms can be maintained at zero temperature Fahrenheit during the entire freezing operation, satisfactory results will be obtained for most products. Some products, however, are much improved by the use of lower freezing temperatures. Diehl (2) has shown that asparagus flavor is improved by using a freezing temperature of —20° Fahrenheit.

Storage temperatures. It has been shown by various investigators that a freezing temperature of zero Fahrenheit also can be used for storage

(1, 2, 3, 4). Temperatures for storage, however, should never exceed 15° Fahrenheit if best results are to be obtained from the storage of fruits and vegetables. It was found at this Station (1) that by increasing the density of sugar solutions, the freezing point of the sugar solution was reduced; consequently, during changes in temperature there was a tendency for the product to thaw and freeze, materially changing the character of the preserved fruit.

Sugar solutions have been found to improve the quality of frozen fruit. They tend to preserve the color and flavor. Diehl (5), as early as 1930, mentioned that strawberry color and flavor were preserved through the use of cane sugar and that the development of yeasts and molds was materially retarded even at relatively high temperatures. In experiments conducted at this Station (1), it was found that a fresh fruit packed with heavy densities of sugar sirup could be held for forty-eight hours without material change in its character. It was concluded therefore, that sugar had some preservative effect on the fruits in connection with freezing storages.

While sugar is an important factor in the preservation of color, flavor, and aroma of the fruit, and likewise has some effect upon the preservation of the fruit at higher temperatures, yet locker storages must of necessity be flexible enough to permit the storage of other products low in sugar content which might spoil without the preservative effect that sugar has upon the tissues. It has therefore been conceded by investigators that for all purposes of storage where fruits, vegetables, meats and fish might be stored under the same conditions, the temperature of the storage room for best results should never exceed 15° above zero Fahrenheit. Locker storages, on the other hand, that must of necessity be utilized at all times for both storage and freezing are best held at a temperature of zero Fahrenheit to meet all requirements of the various foods to be frozen.

The process of alternate thawing and freezing is conducive to mold growth and the development of unpleasant flavors, and should be carefully guarded against. Berry (6) has found that some yeasts grow at temperatures even below zero, indicating that even at lower temperatures care must be exercised to prevent spoilage.

GENERAL METHODS OF PREPARATION

Containers for storage. It has been found through experiments that numerous types of containers can be satisfactorily used for storage. Tin cans of No. 2 and No. 2½ size, as well as larger 5- and 10-pound cans can be used for products for home, institutional, and commercial purposes. For home use, glass jars and paraffined paper cups are suitable. For asparagus, beans and many other products, parchment-lined waxed boxes are now being employed successfully and can be obtained in most of the sizes desired. For those products that oxidize rapidly, tight containers are preferable; but storage in vacuum-packed cans is most satisfactory. To obtain conditions similar to vacuumizing, the product can be covered with sirup or brine, thus preventing direct contact with the air in the container.

Blanching vegetables. Blanching, a process of partly cooking and softening the vegetable for freezing, is essential in the preparation of most vegetables, as it aids cleansing and partly saturates the product with

water. This process does not actually "set" the color as has often been supposed, yet it drives off the air, producing a more brilliant color, characteristic of the particular vegetable.

Another use of the blanch, and possibly the most important one, is to stop enzymatic (fermentation) reactions that cause color changes as well as decomposition. Diehl (2, 8) has indicated that if the enzymes (organic bodies causing fermentation) are permitted to proceed unmolested, breakdown occurs very rapidly, ultimately destroying the flavor and quality of the product. Such activity frequently takes place when foods are frozen. Blanching is important to check the work of these enzymes.

Sugar and salt. Investigations carried on at this Station (1) indicate that sugar can be used in two ways, dry or in solution. When used dry, the sugar should be fairly well distributed over the product, this method serving partly to control oxidation when applied to berries such as strawberries, red raspberries and loganberries, and being particularly effective with fruits such as apricots and peaches.

Sugar solutions were made hot and then cooled before being applied to the fruit. Densities were determined on the basis of weight with the "Balling" or "Brix" hydrometer. To make up a given density solution, for instance of 50° Balling solution, 50 pounds of sugar were used with each 50 pounds of water. A 60-per-cent solution was made with 60 pounds of sugar and 40 pounds of water. Reduced to their lowest terms, these proportions would be 1 to 1 and 3 to 2 for quantities suitable for small packages. As sugar and water weigh almost the same on a volume basis, it has been customary in home operations to use the volume method, but for other purposes the hydrometer is used to correct the solution.

Salt solutions were made on a weight basis. The amount of salt or sugar to use was determined by simply considering the percentage to indicate weight in parts per hundred. For simple measurement use one teaspoonful of salt to one cup of water for a 2-per-cent solution.

Filling the containers. It was found that in filling the containers with liquid, space was necessary to prevent excessive breakage in glass containers. Where the liquid fill came to the lid of the container and the container was closed tightly, there was usually a breakage in the case of glass jars. To overcome this a 1½-inch head space was left, which gave good results. Glass containers were not vacuumized, but in the case of tin many cans were sealed under vacuum with excellent results, especially where no liquid was added to the fruit or vegetable. Vacuumizing was not found necessary in all cases, particularly where sirups or brines were used in connection with the packing of the fruit or vegetable.

Packing vegetables. Vegetables were packed either well-drained or with brine. The use of brine was found extremely advantageous in some cases because it protected the product from the air, as in the case of sirup solutions.

Rapid freezing. It was found important to prepare, pack, and freeze the products quickly. Rapid freezing not only prevents color changes, but also improves and retains the important flavors of the food. Very rapid freezing can be accomplished by placing the fruit on trays, then subjecting the trays to a blast of air at a temperature of zero Fahrenheit. Such a

process has its advantages with many products. Packing can then take place after freezing. According to Diehl (5), freezing the food promptly after preparation prevents changes that might occur in all handling processes. Use of zero temperature in the freezing room will facilitate this operation.

Cooking frozen products. Those persons who have never tried frozen products frequently cook them too long. Products that have been frozen are much more tender than in the fresh state, and therefore will become soft more quickly. Usually they are ready to use with about half the normal cooking for the fresh product.

For vegetables that have been frozen without brine, the water for cooking should first be brought to a boil and the frozen vegetables then be plunged in and allowed to boil until soft.

Vegetables frozen in brine should be allowed to thaw, then drained, and the same brine used for cooking them. Draining, however, is not essential. The product can be placed in a pan on the stove, allowed to thaw, and then boiled, all in one process.

RECOMMENDED METHODS OF PREPARATION FOR BERRIES

Blackberries. Many varieties of blackberries are available in Oregon. The wild Evergreen is a large, succulent berry and is delicious for pies, jellies, or jams. The small wild blackberries, however, are preferred for these purposes, while the domesticated varieties, such as Himalaya and Oregon Evergreen, are preferred for dessert purposes (uncooked).

The berries are prepared by careful sorting and washing. Berries with red druplets—caused by a mite infestation—should be removed as the pack is very uneven in appearance if these berries are included. For best results, pack the fruit with either dry sugar 3 to 1 or with 50-per-cent sirup. Use paraffined cups, glass jars, or enamel-lined tin cans.

Blueberries. Blueberries grown in the Northwest probably afford one of the best fruits for freezing. When defrosted, the berries have a very natural appearance. Some of the outstanding varieties are the Rubel, Rancocus, Grover, Sam, Harding, Pioneer, Cabot, and Adams.

In preparing the blueberries for freezing, they should be thoroughly screened, sorted, and washed before being packed. The fruit can be packed in paraffined cups, glass jars, or enamel-lined tins. Cover with a cold 50-per-cent sirup, seal and freeze.

Cranberries. In Oregon, the McFarlin, Howes, and Centennial cranberry varieties are grown, principally along the coast. These berries freeze well and produce a very suitable product for future use.

Select the riper and more highly colored berries. After sorting, wash carefully and pack, using paraffined cups, glass jars, or enamel-lined tins. Due to air pockets, these berries are very light and heavy sirups cause the fruit to float, making packing difficult. Barely cover the fruit with sirup of 50-per-cent density. Cranberries may be frozen, however, without sugar or sirup.

Loganberries. The loganberry is well adapted to freezing, ripe, firm, berries being best. Wash the fruit carefully and pack in paraffined cups, glass jars, or enamel-lined tins. Dry sugar at the rate of two parts fruit to one part sugar can be used, care being taken to cover the fruit well. If sirup is used, a 50- to 60-per-cent density is best. Because of the tartness of the fruit, some people like the loganberry with even more sugar.

Black raspberries. The varieties grown in Oregon include the Plum Farmer, Cumberland, Munger, and Gregg. None of these varieties makes a very desirable product, owing to the extremely seedy character of the fruit. Packed properly, however, they can be frozen for pie, jam, or dessert purposes. Irrigated berries of these varieties are to be preferred. Only well-filled, plump, succulent fruit should be used. Harvest at the ripe stage before the berries begin to become dry. Sort the fruit carefully and wash in fresh cold water.

Pack into containers and cover with dry sugar, three parts fruit to one part sugar. The berries are preferred when packed in a 40- or 50-per-cent cold sugar sirup, because they are then less dry. They can be frozen in paraffined cups, glass jars, or enamel-lined tins as desired.

Red raspberries. The Cuthbert, Lloyd George, Viking, and other raspberry varieties are suitable for freezing. Red raspberries make one of the best frozen berries, because they hold their flavor well. They should be picked when still firm but full-flavored and sweet. If harvested in a clean manner, washing is not always necessary. Rinsing in cold water tends to plump the berries and removes the dust.

Pack with either a 3 to 1 dry-sugar mixture or with sirup of 50-per-cent density. Paraffined cups, glass jars, or enamel-lined tins can be used. Vacuumizing the tins aids in controlling oxidation.

Strawberries. The Marshall, Corvallis, Clark Seedling, and other strawberry varieties can be frozen very satisfactorily. The fruit should be picked when well colored and ripe, but not soft. Cap and wash, and then pack in containers with a 3 to 1 dry-sugar mixture, or a sirup of 60-per-cent density. Usually the sirup pack looks better, but if properly done the dry-sugar pack has possibilities. When the cans or jars are vacuumized, the appearance of the final dry-sugar pack is greatly improved. If a dry-sugar pack is used, paraffined cups can be employed for storing.

Youngberries. Acreage of the Youngberry, a new berry for Oregon, is gradually being increased. It is a mild-flavored, large berry that is very well adapted to freezing. It can be handled exactly like the loganberry, but when packed with dry sugar the ratio should be changed to 3 parts of berries to 1 of sugar. A density of 30 to 40 per cent for sirup seems heavy enough. Use only enamel-lined tins, glass jars, or paraffined cups.

RECOMMENDED METHODS OF PREPARATION FOR CHERRIES

Black cherries. The varieties of black cherries preserved by freezing are the Black Republican, Bing, and Lambert, outstanding varieties grown in Oregon. The Tartarian is also grown but not on a commercial scale.

Use only well-ripened fruit that has been carefully sorted. Stems may be left on or removed. Wash the fruit before packing. The sirup pack seems the best for black cherries, concentrations of 40 to 50 per cent being satisfactory. Pack the fruit in paraffined cups, glass jars, or enamel-lined tins. Use of the vacuum in packing is helpful in retaining the natural flavor and color, but need not be resorted to for home-packed material.

Sour cherries. The Montmorency is one of the best sour cherries for freezing, although such varieties as the Early Duke and others can be used.

Use only bright red, tree-ripened fruit with a slightly acid taste. Wash, stem, pit, and sort carefully; then pack the fruit in paraffined cups, glass jars, or enamel-lined tin cans. Use dry sugar at the rate of 5 to 1 or cold sirup of 60-per-cent density.

White cherries. The Royal Anne is one of the best-known varieties of white cherries. Pick Royal Annes at the best eating stage when the fruit is well matured but crisp. Stem, wash, and sort; then pack in paraffined cups, glass jars, or plain tin cans. For the best results, cover with a cold sirup of 40- to 50-per-cent density.

RECOMMENDED METHODS OF PREPARATION FOR OTHER FRUITS

Apricots. The Tilton and Blenheim apricot varieties seem to be well adapted to the freezing method of preservation, and although other varieties may be used, these usually give the best results. Apricots are in best condition for freezing when firm and ripe, showing good color and maturity. Soft fruit is to be avoided because freezing contributes to loss of firmness.

Keep the fruit cool and handle it quickly. Avoid bruising. Wash the fruit carefully, then halve and pit. For home preparation, sizing or grading is not necessary, but for commercial packing it is essential. Peeling is not necessary, and the skins help to hold the halves more firmly together. If peeling is desired, however, the fruit can be dipped in boiling water and subjected to steam or lye, as practiced in commercial canning. In case lye has been used, the fruit should be rinsed in a weak citric-acid bath.

After preparation, pack the fruit with sirup in air-tight containers. Vacuum packing is recommended, but fruit packed in non-vacuum glass or tin containers, and carefully sealed, will produce a good product for home use. If tin cans are used, enamel-lined tins are preferable. Sirup densities may vary from 40 to 50 per cent. For a 40-per-cent sirup, use 4 pounds of sugar to 6 pounds of water; for a 50-per-cent sirup, use equal parts of sugar and water. For apricots, dry sugar is not as satisfactory as sirup.

Figs. Although few figs are grown in Oregon, there seems to be a desire to preserve them by freezing. Experiments by Woodroof and Bailey (7) show that this can be satisfactorily done. Figs should be harvested when ripe. Care must be taken to prevent sour or rotten figs from entering the pack.

Wash and sort carefully, removing the stem up to the base of the fig. Pack the fruit, without peeling, in paraffined cups, glass jars, or enamel-

lined cans. Use the dry pack or a sirup with a density of 35 per cent. In most cases the sirup pack will be found the better.

Grapes. Many of the popular varieties of grapes can be frozen. Tokey, Concord, Muscat, and others are suitable. Maturity is essential to obtain full flavor. Wash, sort, and stem carefully, placing the fruit in glass jars or enamel-lined tins. Cover the grapes with a sirup of 40-per-cent density, seal tightly, and freeze.

Peaches. Usually many varieties of peaches are available for freezing, such varieties as the Slappey, J. H. Hale, Elberta, Crawford, and others being used. Rapid handling is necessary because this fruit oxidizes readily. New varieties resistant to oxidation are being developed and may soon be available.

When selecting peaches, choose only those of high quality with predominant flavor. The fruit should be firm and ripe. Handle it quickly by peeling with steam or hot water. If lye is used, be sure to dip in water acidified with citric acid to prevent browning. Cooling is important because it delays the oxidation processes. Sliced peaches are very much better than halves but require more care. Use only air-tight containers such as tin cans or glass jars, the enamel-lined tin being preferred. Vacuum packing is advantageous in preventing browning. Pack in a sirup with a density of 50 per cent and freeze quickly.

Prunes. Italian prunes, tart variety, and Petite or French prune, sweet variety, are the most commonly known for freezing processes.

Harvest when the fruit is still firm but well-colored, and highly flavored. Prunes can be packed whole or pitted. The Italian variety is easily pitted, and is best for this method of packing. After washing and pitting, pack the fruit in glass jars or enamel-lined tins with sugar sirup of 40- or 50-per-cent density, sealing the containers tightly.

RECOMMENDED METHODS OF PREPARATION FOR VEGETABLES

Asparagus. Frozen green asparagus when properly handled has been found satisfactory. Careful sorting is essential to obtain good, succulent, and tender stalks. Prepare and pack quickly to avoid shrinking or shriveling, blanching for 2 to 3 minutes in boiling water and then chilling quickly in cold water. Pack and seal in air-tight containers without further treatment. If the brine pack is desired, containers that will not seal tightly can be used. A 2-per-cent brine is preferred.

A temperature of 20° below zero Fahrenheit has been found by Diehl (5) to be best for freezing but zero temperature can be used. Store at temperatures not exceeding 15° above zero Fahrenheit.

Green and wax beans. The Kentucky Wonder, Refugee, and Blue Lake are the most popular varieties of beans grown. Wax beans have been found quite suitable for freezing. Beans should be harvested while still tender. Snip, wash, and blanch for 2 or 3 minutes. Dip the lot in cold water and chill quickly, then pack "asparagus style" in cans or glass jars,

or in packages well waxed and wrapped. Use of brine is optional. The use of wax-tight parchment wraps, firmly sealed, probably affords as good a way of packaging as can be found.

Lima beans. Succulent, green Lima Beans offer possibilities to those interested in freezing vegetables. They should be harvested while still young and tender, shelled, and then blanched in boiling water for 2 or 3 minutes. Packing is made in containers without brine, using glass, tin, or paraffined cups sealed without vacuum.

Broccoli. Broccoli has been frozen with unusual success, the product never losing its characteristic fresh and beautiful green color. Its attractiveness in the frozen state appeals to the housewife.

Use only the tender stalks with compact heads, sorting carefully and cutting back the stems to the part that is tender. Pack in such a form that rehandling will not be necessary after freezing and thawing. Blanch in boiling water 3 or 4 minutes and cool in fresh rinsing water.

Broccoli can be packed in packages similar to those indicated for beans. This type of packaging seems most suitable, although plain cans may be used.

Cauliflower. Cauliflower can be frozen after being carefully trimmed. Remove all the green leaves and cut the larger curds apart, then soak for a short time in a weak brine solution. Blanch in boiling water for 2 or 3 minutes, cooling promptly and packing immediately.

This product can be packed in either air-tight containers or paraffined packages well wrapped to prevent moisture loss. Freezing in 2-per-cent brine solution will give good results, but dry packing is satisfactory.

Sweet corn. Freezing corn either on or off the cob has been found very satisfactory by Diehl and Berry (5). When frozen, Golden Bantam, Golden Bantam Cross (Hybrid), Stowell's Evergreen, and other varieties have proved delicious and more like the natural fresh corn than the same product preserved in other ways. Harvest when the corn is at the right stage of maturity, still in a slightly milky stage and tender.

If ears are not husked, blanch in boiling water for at least 6 to 8 minutes; if husked, blanching need not exceed 6 minutes. Pack the corn on the cob, with the husks, in paraffined boxes, tightly wrapped with wax paper. Corn on the cob may be packed in tin cans of either sealed or friction-top style. Large slip-cover cans holding from five to ten ears are satisfactory. For corn off the cob, simply cut the corn off but do not scrape the cob, then place in cans or glass jars as desired, and seal tight.

Mushrooms. According to some investigators, mushrooms offer possibilities for freezing. The small button-sized mushrooms are found better for this purpose. Care must be taken in handling so as not to damage the caps lest discolorations appear.

Sort, size if necessary, and wash carefully, then blanch the mushrooms in boiling water for 2 to 4 minutes, depending on size, and cool rapidly. Packing is done preferably in air-tight containers, if the dry-pack method is used. Use of a 2-per-cent brine for packing will improve the color.

Peas. The large-size garden peas of the Alderman, Stratagem, or Telephone varieties may be used. They should be picked at the tender, succulent stage when best suited for table use. Hull, wash, and blanch them in boiling water for ½ to 1½ minutes, cooling quickly in plenty of fresh water. The peas can be packed dry or in brine of 2-per-cent density. Seal in glass jars, tin cans, parchment-lined wax packages, or paraffined cups. Jars or cans are preferred.

Spinach. Although somewhat difficult to handle, spinach makes a very good frozen product. Care must be used to see that the spinach is not too far advanced in maturity. It should be well washed to remove all sand and grit. Blanching is done in boiling water for 2 to 2½ minutes. Rinse well in cold water, drain, and pack without added liquid in glass jars, cans, parchment-lined, paraffined, or waxed packages.

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Table 1. FROZEN FRUIT PACK TABLE.

Kind of fruit	Method of preparation	Type of container	Method of packing
Berries			
Blackberries	Sort, wash, and pack.	Glass jars, enamel-lined tin cans, or paraffined cups.	Dry sugar 3 to 1 or 50° Balling sirup to cover fruit.
Blueberries	Screen, sort, and wash carefully.	Paraffined cups, glass jars, or enamel-lined cans.	Use a 50° Balling cold sirup to cover fruit.
Cranberries	Select ripe, well-colored berries, wash, and pack.	Paraffined cups, glass jars, or enamel-lined cans.	Use 50° Balling cold sirup to cover fruit.
Loganberries	Sort, wash, and pack.	Paraffined cups, glass jars, or enamel-lined tins.	Dry sugar 3 to 1 or 50° to 60° Balling cold sirup to cover fruit.
Raspberries (Black)	Sort, wash, and pack.	Paraffined cups, glass jars, or enamel-lined tin cans.	Dry sugar 3 to 1 or 40 to 50° Balling cold sirup to cover fruit.
Raspberries (Red)	Sort, wash, and pack.	Paraffined cups, glass jars, or enamel-lined tin cans.	Dry sugar 3 to 1 or 50° Balling cold sirup to cover fruit.
Strawberries	Can, sort, and wash carefully.	Paraffined cups, glass jars, or enamel-lined tin cans.	Dry sugar 3 to 1 or 60° Balling cold sirup to cover fruit.
Youngberries	Sort and wash carefully.	Paraffined cups, glass jars, or enamel-lined tin cans.	Dry sugar 3 to 1 or 30 to 40° Balling cold sirup to cover fruit.
Cherries			
Cherries, black	Stem, wash, and pack with or without pits.	Paraffined cups, glass jars, or enamel-lined cans. Vacuum pack improves the product.	Use a 50° Balling cold sirup to cover fruit.
Cherries, sour	Stem, wash, sort, pit, and pack.	Paraffined cups, glass jars, or enamel-lined cans.	Dry sugar 3 to 1 or a 60° Balling cold sirup to cover fruit.
Cherries, white	Stem, wash, sort, and pack.	Paraffined cups, glass jars, plain tin cans.	Use 40 to 50° Balling cold sirup to cover fruit.
Other fruits			
Apricots	Avoid bursing; handle quickly; wash, halve, and pit.	Glass jars, or enamel-lined tin cans.	Use 40 or 50° Balling cold sirup and cover fruit.
Figs	Sort and wash carefully. Remove stem up to base of fig.	Paraffined cups, glass jars, or enamel-lined cans.	Use 35° Balling cold sirup or pack dry.
Grapes	Wash, stem, sort, and pack.	Enamel-lined tins or glass jars.	Use 40° Balling cold sirup to cover fruit.
Peaches	Peel, pit, halve or slice; pack promptly.	Enamel-lined tin cans or glass jars. Vacuum pack preferable.	Use 50° Balling cold sirup to cover fruit.
Prunes	Sort, wash, halve, and pit.	Enamel-lined tin cans or glass jars.	Use a 40 or 50° Balling cold sirup to cover fruit.

NOTE: Freezing temperatures of 5° below to 5° above zero Fahrenheit have been found satisfactory for these products. Storage may be at the same temperatures as those used for freezing. Never allow the temperatures for storage to rise above 15° Fahrenheit.

For more detailed information on packing, refer to text.

Table 2. FROZEN VEGETABLE PACK TABLE.

Kind of vegetable	Method of preparation	Type of container	Method of packing
Asparagus	Sort, wash, and blanch 2 to 3 minutes in boiling water; chill and pack.	Parchment-lined waxed containers, tin cans, or glass jars.	Pack dry or cover with 2-per-cent brine.
Green and wax beans	Snip, sort, wash, blanch 2 to 3 minutes in boiling water; chill and pack.	Parchment-lined waxed containers, tin cans, or glass jars.	Pack dry or cover with 2-per-cent brine.
Lima beans	Shell, sort, blanch 2 to 3 minutes in boiling water; chill and pack.	Paraffined cups, glass jars, or tin cans.	Pack dry.
Broccoli	Use only tender stalks with compact heads. Cut back stems. Blanch 3 to 4 minutes in boiling water; chill and pack.	Parchment-lined waxed containers, tin cans, or glass jars.	Pack dry.
Cauliflower	Remove green leaves. Cut curds apart. Soak short time in weak brine. Blanch in boiling water 2 to 3 minutes and chill.	Parchment-lined waxed containers carefully packed to prevent moisture loss, tin cans, or glass jars.	Pack dry or cover with 2-per-cent brine.
Mushrooms	Use small buttons and wash carefully. Blanch 2 to 4 minutes and chill.	Pack in air-tight containers such as tin cans or glass jars.	Use 2-per-cent brine although dry pack may be used.
Peas	Hull and blanch in boiling water for ½ to 1½ minutes; chill and pack.	Parchment-lined waxed boxes, glass jars, or tin cans.	Pack dry or cover with 2-per-cent brine.
Spinach	Sort the leaves, wash carefully, blanch 2 to 2½ minutes in boiling water; chill.	Parchment-lined waxed boxes, glass jars, or plain tin cans.	Pack dry.
Sweet corn	Blanch corn with husks 6 to 8 minutes or 6 minutes without husks; pack either way.	Parchment-lined waxed boxes, glass jars, or tin cans.	Pack dry.

NOTE: Freezing temperatures of 5° below to 5° above zero Fahrenheit have been found satisfactory for these products. Storage may be at the same temperatures as those used for freezing. Never allow the temperature for storage to rise above 15° Fahrenheit.

For more detailed information on packing, refer to text.

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Division of Agricultural Economics

E. L. Potter, M.S.....Agricultural Economist; In Charge, Division of Agri. Economics

Agricultural Economics

W. H. Dreesen, Ph.D.....Agricultural Economist

Farm Management

A. S. Burrier, M.S.....Economist (Farm Management)
H. D. Scudder, B.S.....Economist (Farm Management)
G. W. Kuhlman, M.S.....Associate Economist (Farm Management)

Division of Animal Industries

P. M. Brandt, A.M.....Dairy Husbandman; In Charge, Division of Animal Industries

Animal Husbandry

O. M. Nelson, M.S.....Animal Husbandman
R. G. Johnson, B.S.....Animal Husbandman
A. W. Oliver, M.S.....Assistant Animal Husbandman

Dairy Husbandry

G. H. Wilster, Ph.D.....Dairy Husbandman
I. R. Jones, Ph.D.....Associate Dairy Husbandman

Fish and Game Management

R. E. Dimick, M.S.....Wildlife Conservationist in Charge
F. P. Griffiths, Ph.D.....Assistant Conservationist (Fish and Game Management)
A. S. Einarsen, B.S.....Associate Biologist*

Poultry Husbandry

H. E. Cosby.....Poultry Husbandman
F. L. Knowlton, M.S.....Poultry Husbandman
F. E. Fox, M.S.....Associate Poultry Husbandman

Veterinary Medicine

B. T. Simms, D.V.M.....Veterinarian
W. T. Johnson, B.S., D.V.M.....Poultry Pathologist
J. N. Shaw, B.S., D.V.M.....Associate Veterinarian
F. M. Bolin, D.V.M.....Assistant Veterinarian*
O. H. Muth, D.V.M., M.S.....Assistant Veterinarian
R. Dougherty, D.V.M.....Assistant Veterinarian*
A. S. Rosenwald, B.S., D.V.M.....Assistant Poultry Pathologist
O. L. Searcy, B.S.....Technician*

Division of Plant Industries

G. R. Hyslop, B.S.....Agronomist; In Charge, Division of Plant Industries

Farm Crops

H. A. Schoth, M.S.....Agronomist; Forage Crops and Disease Investigation*
D. D. Hill, Ph.D.....Associate Agronomist
R. E. Fore, Ph.D.....Assistant Agronomist*
B. B. Robinson, Ph.D.....Assistant Plant Breeder, Fiber Flax Investigations*
Grace Cole Fleischman, A.B.....Assistant Botanist, Division of Seed Investigations*
H. H. Rampton, M.S...Assist. Agronomist; Forage Crops and Disease Investigation*
L. E. Harris, M.S.....Assistant Agronomist

Horticulture

W. S. Brown, M.S., D.Sc.....Horticulturist
A. G. B. Bouquet, M.S.....Horticulturist (Vegetable Crops)
E. H. Wiegand, B.S.A.....Horticulturist (Food Products Industries)
H. Hartman, M.S.....Horticulturist (Pomology)
C. E. Schuster, M.S.....Horticulturist (Div. Fruits and Veg. Crops and Diseases)*
W. P. Duruz, Ph.D.....Horticulturist (Plant Propagation)
G. F. Waldo, M.S.....Asst. Pomologist (Div. Fruits and Veg. Crops and Diseases)*
T. Onsdorff, M.S.....Assistant Horticulturist (Food Products Industries)
E. Hansen, M.S.....Assistant Horticulturist (Pomology)

STATION STAFF—*(Continued)*

Soil Science

W. L. Powers, Ph.D.—Soil Scientist
C. V. Ruzek, M.S.—Soil Scientist (Fertility)
M. R. Lewis, C.E.—Irrigation and Drainage Engineer, Bur. of Agric. Engineering*
R. E. Stephenson, Ph.D.—Associate Soil Scientist
E. F. Torgerson, B.S.—Associate Soil Scientist (Soil Survey)

Other Departments

Agricultural Chemistry

J. S. Jones, M.S.A.—Chemist in Charge
R. H. Robinson, M.S.—Chemist (Insecticides and Fungicides)
J. R. Haag, Ph.D.—Chemist (Animal Nutrition)
D. E. Bullis, M.S.—Associate Chemist (Food Products Industries)
M. B. Hatch, M.S.—Assistant Chemist

Agricultural Engineering

F. E. Price, B.S.—Agricultural Engineer in Charge
H. R. Sinnard, M.S.—Associate Agricultural Engineer (Farm Structures)
C. I. Branton, B.S.—Assistant Agricultural Engineer

Bacteriology

G. V. Copson, M.S.—Bacteriologist in Charge
J. E. Simmons, M.S.—Associate Bacteriologist
W. B. Bollen, Ph.D.—Associate Bacteriologist

Entomology

D. C. Mote, Ph.D.—Entomologist in Charge
W. J. Chamberlin, Ph.D.—Associate Entomologist
J. C. Chamberlin, Ph.D.—Assoc. Entomologist; Truck Crops and Garden Insects*
B. G. Thompson, M.S.—Assistant Entomologist
S. C. Jones, M.S.—Assistant Entomologist
K. W. Gray, M.S.—Field Assistant (Entomology)
W. D. Edwards, B.S.—Field Assistant (Entomology)

Home Economics

Maud M. Wilson, A.M.—Home Economist

Plant Pathology

C. E. Owens, Ph.D.—Plant Pathologist in Charge
S. M. Zeller, Ph.D.—Plant Pathologist
F. P. McWhorter, Ph.D.—Plant Pathologist*
B. F. Dana, M.S.—Plant Pathologist (Div. Fruits and Vegetable Crops Diseases)*
F. D. Bailey, M.S.—Associate Plant Pathologist (Insecticide Control Division)*
P. W. Miller, Ph.D.—Assoc. Pathologist (Div. Fruits and Veg. Crops and Dis.)*
G. R. Hoerner, M.S.—Agent (Hop Disease Investigations)*
A. R. Sprague, Jr., Ph.D.—Assistant Pathologist (Cereal Diseases)*
H. H. Millsap—Agent (Division of Fruits and Vegetable Crops and Diseases)*

Publications and News Service

C. D. Byrne, M.S.—Director of Information
E. T. Reed, B.S., A.B.—Editor of Publications
D. M. Goode, B.A.—Editor of Publications
J. C. Burtner, B.S.—Associate in News Service

Branch Stations

D. E. Stephens, B.S.—Supt., Sherman Br. Expt. Sta., Moro; Sr. Agronomist*
L. Childs, A.B.—Superintendent, Hood River Br. Expt. Station, Hood River
F. C. Reimer, M.S.—Superintendent, Southern Oregon Br. Expt. Station, Talent
D. E. Richards, B.S.—Supt. Eastern Oregon Livestock Br. Expt. Sta., Union
H. K. Dean, B.S.—Superintendent, Umatilla Br. Expt. Station, Hermiston*
O. Shattuck, M.S.—Superintendent, Harney Valley Br. Expt. Station, Burns
H. B. Howell, B.S.—Superintendent, John Jacob Astor Br. Expt. Sta., Astoria
R. G. Johnson, B.S.—Acting Supt., Squaw Butte Range Experiment Station
G. A. Mitchell, B.S.—Asst. Supt. Pendleton Br. Expt. Sta., Pendleton; Asst. Agron.*
G. G. Brown, A.B., B.S.—Horticulturist, Hood River Br. Expt. Station, Hood River
Arch Work, B.S.—Associate Irrigation Engineer, Medford*
W. W. Aldrich, Ph.D.—Assistant Horticulturist, Bureau of Plant Industry, Medford*
L. G. Gentner, M.S.—Associate Entomologist, So. Or. Br. Expt. Sta., Talent
J. F. Martin, M.S.—Junior Agronomist, Div. Cereal Crops and Diseases, Pendleton*
M. M. Oveson, M.S.—Assistant to Supt., Sherman Br. Experiment Station, Moro*
R. B. Webb, M.S.—Jr. Agronomist, Sherman Branch Experiment Station, Moro
R. E. Hutchison, B.S.—Asst. to Supt., Harney Branch Expt. Station, Burns

FRUIT AND VEGETABLE PRESERVATION BY FREEZING

It has been found that freezing rooms or locker storages are best maintained at a temperature of 5° below to 5° above zero Fahrenheit. This temperature has been found quite satisfactory for freezing and storing. For storage the temperature should never exceed 15° Fahrenheit for the best results.

Dry-sugar and sirup packs have both been found satisfactory for the preserving of most fruits. For dessert purposes sirup pack has been found very good. Dry-sugar pack lends itself well where the product is to be used for ice-cream making or in the manufacture of toppings in soda-fountain supplies. Sugar solutions of 50-per-cent density seem to be satisfactory for most products, while three plus one dry-sugar mix answers for all dry-sugar-packed fruits.

Containers for storage include those that can be sealed tightly—either glass or tin that has been enamel-lined. Good wax-tight containers that can be sealed have been found suitable for almost all classes of products.

Vegetables can be satisfactorily packed either with or without brine. Where brine is used a 2-per-cent solution has been found adequate.

Blanching is necessary for most vegetable products and for fruit products where peeling becomes necessary, as in the case of peaches. Blanching checks enzymatic activities and delays oxidation.

Rapid freezing is essential. Products that have been blanched should be chilled quickly and removed to the freezer as soon as possible. The use of zero temperatures in all cases seems advantageous.